

WHAT IS CLAIMED IS:

- 1 1. An immersion lithographic system comprising;  
2 a stage;  
3 a semiconductor structure disposed on the stage, the semiconductor structure having a  
4 topmost layer of photosensitive material that has a thickness of less than about 5000 angstroms;  
5 an optical surface; and  
6 an immersion fluid disposed between the semiconductor structure and the optical surface,  
7 the immersion fluid in contact with the topmost layer of photosensitive material.
- 1 2. The system of claim 1 wherein the immersion fluid comprises water.
- 1 3. The system of claim 1 wherein the immersion fluid comprises a fluid selected from the  
2 group consisting of cyclo-otance and perfluoropolyether.
- 1 4. The system of claim 1 wherein the thickness of the photosensitive material is less than  
2 about 3000 angstroms.
- 1 5. The system of claim 4 wherein the thickness of the photosensitive material is less than  
2 about 1000 angstroms.
- 1 6. The system of claim 1 wherein the optical surface comprises silicon and oxygen.
- 1 7. The system of claim 1 wherein the optical surface comprises fused silica.
- 1 8. The system of claim 1 wherein the optical surface comprises calcium fluoride.
- 1 9. The system of claim 1 wherein the photosensitive material is a chemically amplified  
2 photoresist.

1 10. The system of claim 1 wherein the semiconductor structure is immersed in the immersion  
2 fluid.

1 11. The system of claim 1 and further comprising a radiation source.

1 12. The system of claim 11 wherein the stage is immersed in the immersion fluid.

1 13. An immersion lithographic system, comprising:  
2 a light source for projecting light having a wavelength of less than or equal to about 193  
3 nm;  
4 an optical component arranged to received light from the light source, the optical  
5 component having an optical surface;  
6 a semiconductor structure having a topmost layer of photosensitive material that has a  
7 thickness of less than about 5000 angstroms, the semiconductor structure arranged to receive  
8 light from the optical component; and  
9 liquid containing water contacting at least a portion of the optical surface and at least a  
10 portion of the photosensitive material.

1 14. The system of claim 13 wherein the thickness of the photosensitive material is less than  
2 about 3000 angstroms.

1 15. The system of claim 14 wherein the thickness of the photosensitive material is less than  
2 about 1000 angstroms.

1 16. The system of claim 13 wherein the optical surface comprises silicon oxide.

1 17. The system of claim 13 wherein the optical surface comprises fused silica.

1 18. The system of claim 13 wherein the optical surface comprises calcium fluoride.

1 19. The system of claim 13 wherein the photosensitive material is a chemically amplified  
2 photoresist.

1 20. The system of claim 13 wherein the semiconductor structure is immersed in the liquid  
2 containing water.

1 21. The system of claim 13 further comprising a stage underlying the semiconductor  
2 structure.

1 22. The system of claim 21 wherein the stage is immersed in the liquid containing water.

- 1 23. A method for illuminating a semiconductor structure having a topmost photoresist layer,  
2 the method comprising;  
3 providing a semiconductor structure having a photoresist layer, the photoresist layer  
4 having a thickness of less than 5000 angstroms formed on a surface thereof;  
5 introducing an immersion fluid into a space between an optical surface and the  
6 photoresist layer; and  
7 directing optical energy through the immersion fluid and onto the photoresist layer.
- 1 24. The method of claim 23 wherein the immersion fluid comprises water.
- 1 25. The method of claim 23 wherein the optical energy comprises light having a wavelength  
2 of less than about 450 nm.
- 1 26. The method of claim 23 wherein the optical surface comprises silicon oxide.
- 1 27. The method of claim 23 wherein the optical surface comprises calcium fluoride.
- 1 28. The method of claim 23 wherein the photoresist layer comprises a chemically amplified  
2 photoresist.
- 1 29. The method of claim 23 wherein the immersion fluid is in contact with a portion of the  
2 photoresist layer.
- 1 30. The method of claim 23 wherein the semiconductor structure is immersed in the  
2 immersion fluid.

- 1 31. The method of claim 23 further comprising a stage underlying the semiconductor  
2 structure.
- 1 32. The method of claim 31 wherein the stage is immersed in the immersion fluid.
- 1 33. The method of claim 23 further comprising developing the photoresist.
- 1 34. The method of claim 33 wherein developing the photoresist comprises immersing the  
2 photoresist in a tetramethylammonia hydroxide solution.
- 1 35. The method of claim 23 wherein the semiconductor structure further comprises a barrier  
2 layer formed over the photoresist layer.
- 1 36. The method of claim 35 wherein the barrier layer comprises a hydrophobic material.

1 37. A method of fabricating a semiconductor device, the method comprising:  
2 providing a semiconductor wafer;  
3 forming a photoresist layer over the semiconductor wafer, the photoresist layer having a  
4 thickness of less than about 5000 angstroms;  
5 introducing an immersion fluid into a space between an optical surface and the  
6 photoresist layer, the immersion fluid contacting the photoresist layer;  
7 patterning the photoresist by directing optical energy through the immersion fluid and  
8 onto the photoresist; and  
9 removing portions of the photoresist in accordance with a pattern from the patterning  
10 step; and  
11 processing the semiconductor wafer using remaining portions of the photoresist as a  
12 mask.

1 38. The method of claim 37 wherein the immersion fluid comprises water.

1 39. The method of claim 38 wherein the optical energy comprises light having a wavelength  
2 of less than 450 nm.

1 40. The method of claim 37 wherein the optical surface comprises silicon oxide.

1 41. The method of claim 37 wherein the optical surface comprises calcium fluoride.

1 42. The method of claim 37 wherein the photoresist layer comprises a chemically amplified  
2 photoresist.

- 1 43. The method of claim 37 wherein the semiconductor wafer is immersed in the immersion  
2 fluid.
- 1 44. The method of claim 37 further comprising placing the semiconductor wafer on a stage.
- 1 45. The method of claim 44 wherein the stage is immersed in the immersion fluid.
- 1 46. The method of claim 37 and further comprising developing the photoresist.
- 1 47. The method of claim 46 wherein the step of developing the photoresist comprises  
2 immersing the photoresist in a tetramethylammonia hydroxide solution.
- 1 48. The method of claim 47 wherein the optical energy has a wavelength of less than 450 nm.
- 1 49. The method of claim 37 wherein providing a semiconductor wafer comprises providing a  
2 semiconductor wafer with a layer of material deposited thereon, wherein forming a phototresist  
3 layer comprises forming a photoresist layer over the layer of material, and wherein effecting the  
4 semiconductor wafer comprises etching the layer of material.
- 1 50. The method of claim 49 wherein the layer of material comprises a conductive layer.
- 1 51. The method of claim 50 wherein processing the semiconductor wafer comprises etching  
2 the conductive layer into gate electrodes.
- 1 52. The method of claim 51 wherein each gate electrode have a minimum dimension of 50nm  
2 or less.



- 1 53. The method of claim 49 wherein the layer of material comprises a dielectric layer.
- 1 54. The method of claim 53 wherein processing the semiconductor wafer comprises forming  
2 trenches in the dielectric layer, the method further comprising filling the trenches with a  
3 conductor.
- 1 55. The method of claim 37 and further comprising forming a barrier layer over photoresist  
2 layer.
- 1 56. The method of claim 55 wherein forming a barrier layer comprises plasma treating an  
2 upper surface of the photoresist layer.
- 1 57. The method of claim 55 wherein the barrier layer is formed by treating an upper portion  
2 of the photoresist layer.
- 1 58. The method of claim 57 wherein treating the upper portion of the photoresist layer  
2 comprises performing a chemical treatment.
- 1 59. The method of claim 57 wherein treating the upper portion of the photoresist layer  
2 comprises performing an ion implantation process.
- 1 60. The method of claim 57 wherein treating the upper portion of the photoresist layer  
2 comprises performing a thermal treatment.